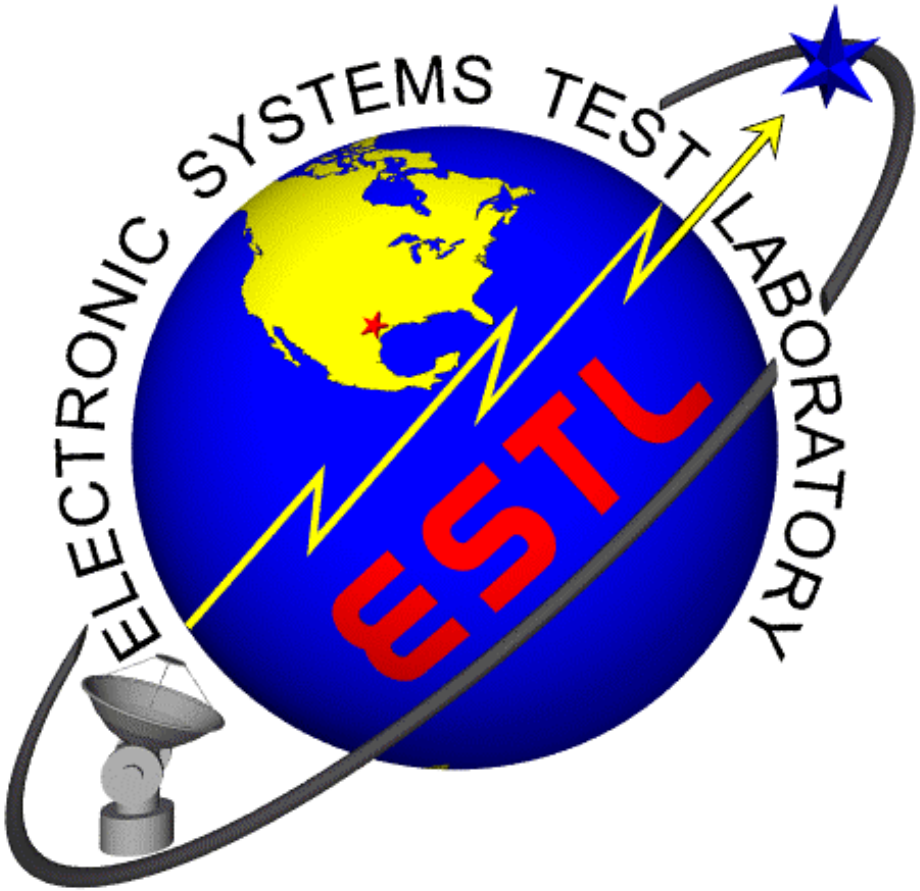
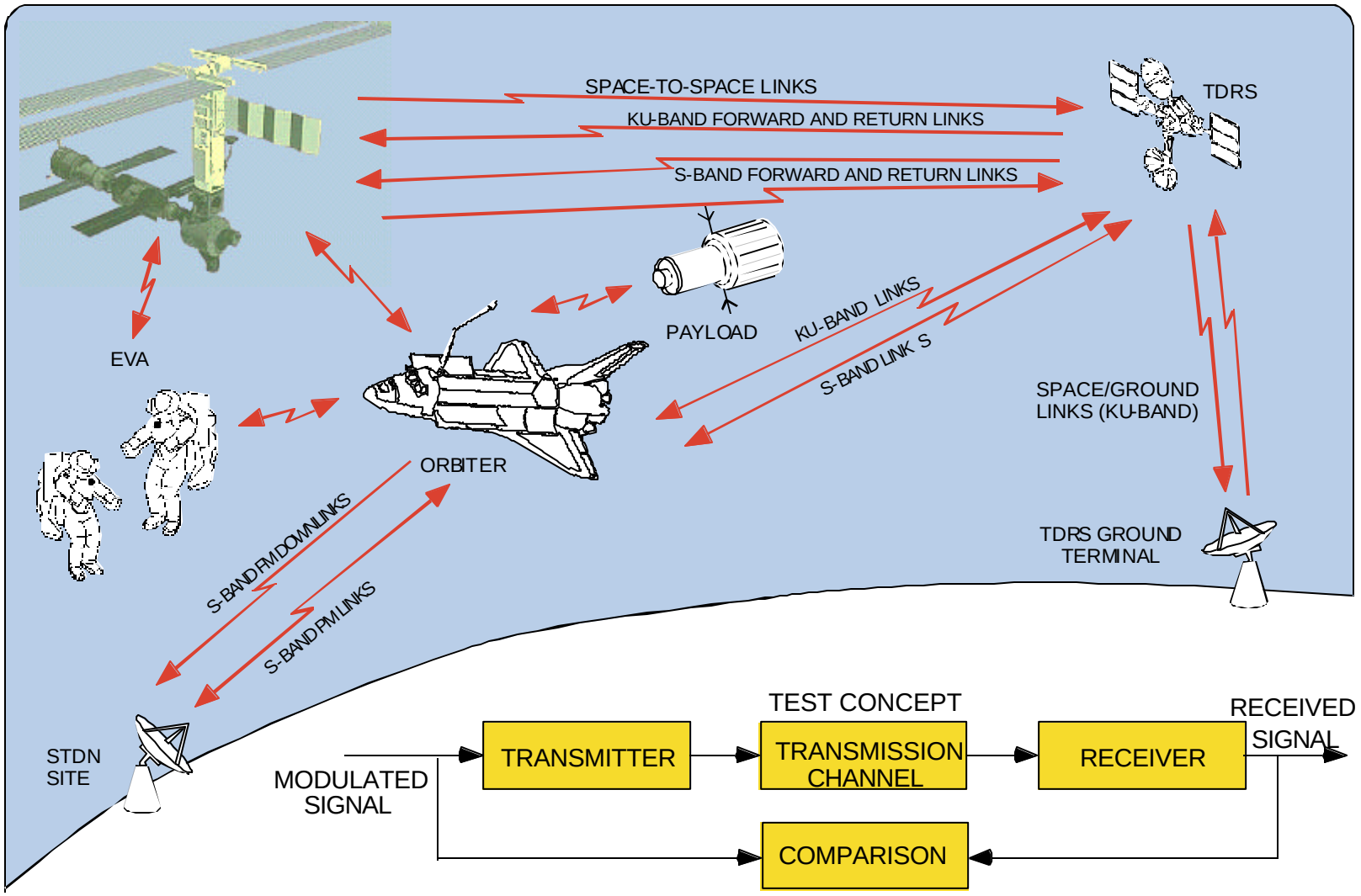
NASA Johnson Space Center *Avionic Systems Division* *Systems Analysis & Test Branch*	**Subject:** ESTL Overview	**Name:** Mario Delgado	
		Date: Sept. 2002	**Page:** 1



ESTL TEST CONCEPT



All communications scenarios pictured as well as MCC data processing can be emulated in the ESTL test bed

Hardware/Software

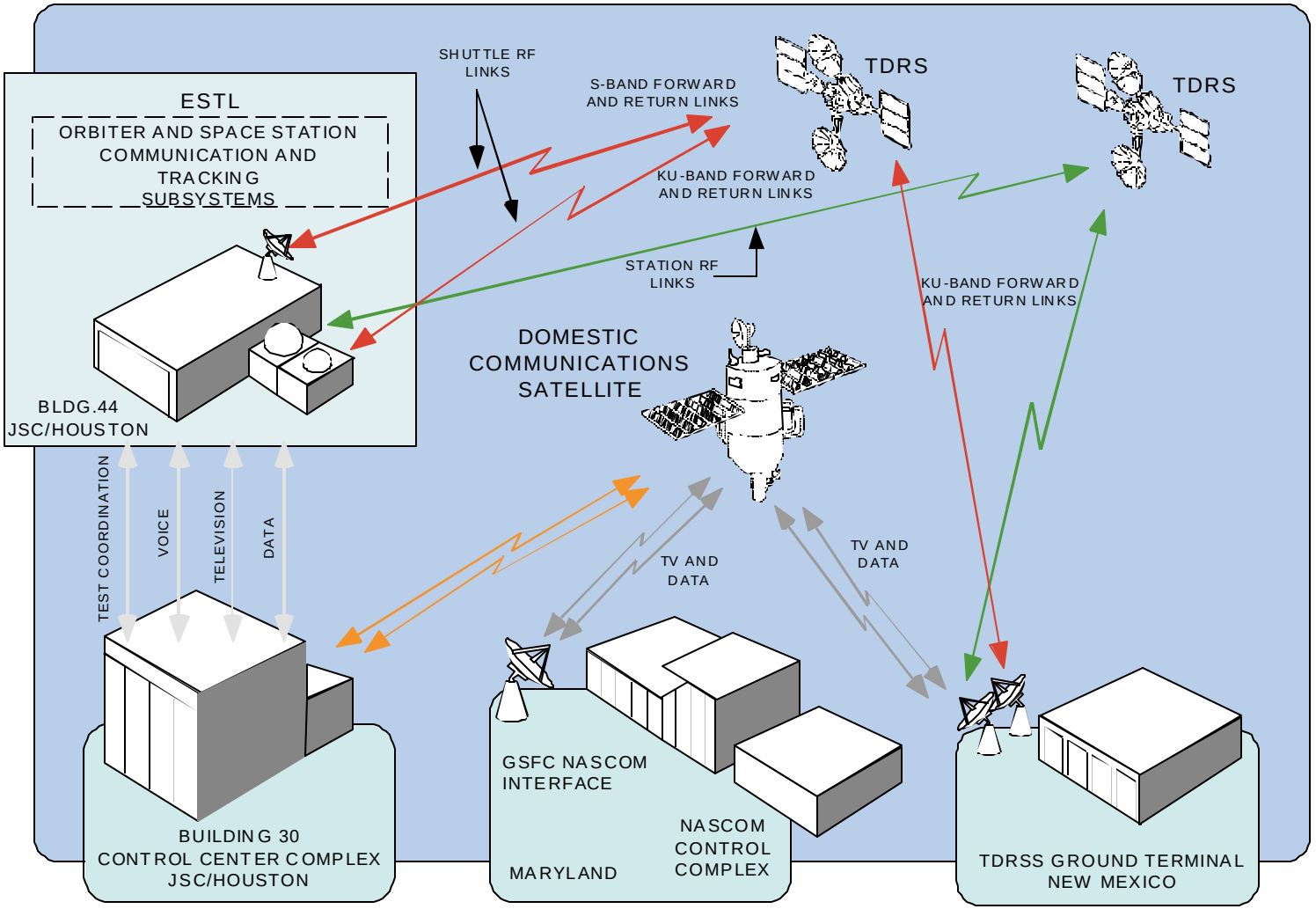
? ESTL facility represents a $150 million capital equipment investment containing 18,500 square feet of active floor space

? As an end-to-end testbed the ESTL contains high-fidelity equipment of both ground and spacecraft communications systems

? Significant features of the ESTL include the following:

- ? Five RF shielded enclosures for spacecraft testing
- ? High fidelity equipment of both types of ground stations
  - GSTDN direct link ground station,
  - TDRS Ground Terminal
- ? A TDRS satellite communication system with S-band single access (SSA) and Ku-band single access (KSA) capability
- ? Unique test instrumentation systems, including Dynamic Doppler Frequency profiles and accurate, controlled, dynamic space loss emulation
- ? Space Shuttle Orbiter Ku-band, S-band, and ultrahigh frequency (UHF) prototype and/or qualification units (including encryption equipment)
- ? GFE products such as SSCS, OIU, ECOMM
- ? A roof mounted, 16-foot S-band antenna system
- ? Three antenna radomes for RF transmission/reception from on orbit spacecraft or TDRS's

ESTL/TDRSS INTERFACE TEST CONFIGURATION



ESTL transmits to TDRSS network for Shuttle/Station/GFE/payload mission pre-flight checkouts/tests and hardware, firmware, and software modification checkouts for MCC and STGT

ESTL Products: we provide

? In depth RF communications performance verification and characterization testing for all Human Spaceflight Programs

? In depth RF characterization testing for payloads, satellites, and other unmanned vehicles

? Shuttle and Station RF Anomaly Resolution Test Bed - Pre-launch, Real-time and Post-flight

? Support to TDRSS Network Shuttle Pre-launch Verification/Validation Tests, TDRS checkout,TDRSS Network Firmware checkouts

? Avionics GFE development and verification testing

? Venue for future R&D communications ventures

? RF Communication Certification

? MCC Ground Support

ESTL provides complete life cycle test capability for all programs.

? Analysis model verification
? Design Development (e.g. OCA, HDTV)
? System Verification (Shuttle & Station S-band, Ku-band,UHF)
? System Certification (ECOMM, SSCS)
? System preflight checkout (Hubble Space Telescope)
? On-Orbit support (FM System TV downlink first orbit)
? On-Orbit anomaly investigation/resolution
? Sustaining engineering of operational systems

Experience

? Highly trained and experienced test team in place with over 39 years of corporate knowledge in RF Communication Systems Testing

? Complex, specialized test techniques developed and continuously refined over the life of the facility

? Specialized test equipment developed in-house to support unique test needs

? ESTL ground station support personnel (Honeywell) provided by operational ground station support contractor also with 39 years experience supporting manned programs

? ESTL test personnel highly familiar with mission operations (Ground Network and MOD)

? ESTL personnel highly familiar with Shuttle and Station communication systems

? Personnel are cross-trained and have more than one function in the ESTL

Space Shuttle Orbiter

? Ku-band
    ? EA1
    ? Signal Processor
    ? Ku-band Deployed Assembly System (antenna)
? S-band
    ? PA
    ? NSP
    ? Transponder
    ? Antenna Switch Assembly
    ? Preamp
    ? ATU
    ? ACCU
    ? FM Transmitter
    ? FM signal processor
? Other
    ? OIU
    ? SSOR

International Space Station

? Test Bed can accept DVTM or Flight Units
? Space to Ground System (SGS) Antenna (proto-flight spare)
? SSSR

Ground Stations

? Second TDRS Ground Station (exact copy)

? Ground Tracking Data Network (exact copy)

TDRS Satellite Simulator (electrically equivalent)

Ground Processing Equipment

? Front End Processor (station and shuttle)

? GSTDN ground processing hardware (MBR)

Calibrated hard-line RF Paths for S-band, Ku-band, and UHF

? 5 Shielded Enclosures
? Calibrated continuously-variable Attenuators; DC-4GHz, 12-18GHz

Antennae

? Three antenna radomes for RF transmission/reception from on orbit spacecraft or TDRS's
? Roof mounted, 16-foot S-band antenna system

Bit and Frame Error Equipment

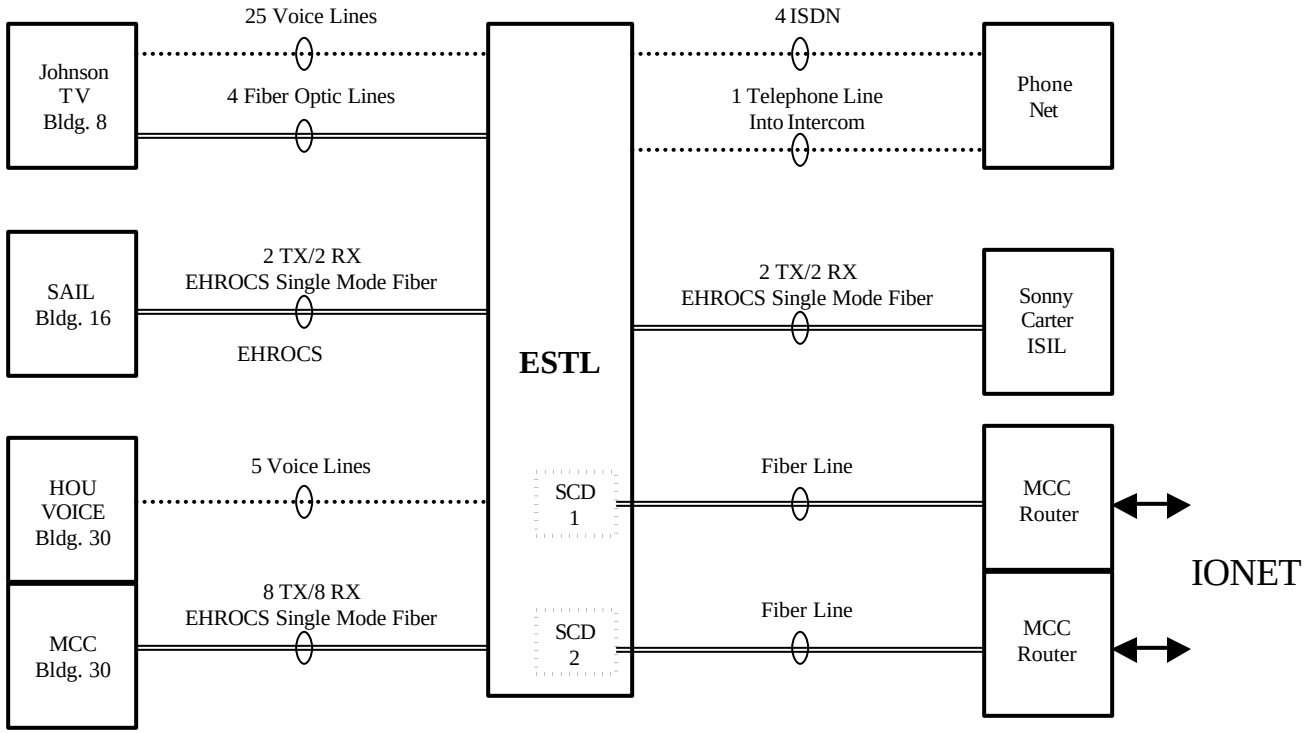
? High Rate Open and Closed Loop Bit Error Detectors, DC to 100Mbps
? Open Loop Bit Error Detectors to 700Mbps
? Frame Sync Status Detectors

Interfaces to MCC, SAIL, ISIL

? EHROCS (fiber equipment)
? Analog Voice
? SDI

Support

? ESTL Display system
? Electronic Monitoring Alarm System (e.g., over-temp, over-voltage)
? ISS Data Handling System (BSP Simulator, control station boxes)


Johnson TV Bldg. 8
25 Voice Lines
4 Fiber Optic Lines
4 ISDN
1 Telephone Line Into Intercom
Phone Net
SAIL Bldg. 16
2 TX/2 RX EHROCS Single Mode Fiber
EHROCS
2 TX/2 RX EHROCS Single Mode Fiber
Sonny Carter ISIL
ESTL
HOU VOICE Bldg. 30
5 Voice Lines
SCD 1
Fiber Line
MCC Router
IONET
MCC Bldg. 30
8 TX/8 RX EHROCS Single Mode Fiber
SCD 2
Fiber Line
MCC Router

External customers use the Space Act Agreement vehicle to work with ESTL

External Space Shuttle Customers

? European Space Agency

? Russian Space Agency.

External Space Station Customers

? European Space Agency

? Naval Research Laboratory

Other Customers

? Provided testbed and additional expertise for Spacehab to develop a telemetry link multiplex interface with the Shuttle Ku-band Signal Processor (Ku-SP), Space Network, and Mission Control Center

? Discussing tests for Spacehab related to compatibility with Inmarsat

Digital Operational Recorder
? Nonflight unit to replace the engineering unit used by ESTL

Solid State Recorder (Mass Memory Unit (MMU))
? Replacement for the Operational Recorder
? Only plays back in forward direction
? Has playback rates (2048, 1024, 960, 192, 128, & 60 kbps)
? ESTL developed and ATP'd a controller that operates thru the MDM port

Space-to-Space Communications System (SSCS)
? Replacement for EVA backpack
? ESTL maintains an SSOR, SSSR, and SSER (can accommodate 2 more SSER units)
? Currently developing a monitoring system to display the status of the radio network

DTV MUX/DEMUX
? Integrated a flight DTV MUX and a GSE DEMUX into the ESTL testbed
? SDI tie lines were installed this year that allow for signal interface with MCC DTV GSE

ESTL High Rate Optical Communications System (EHROCS)

? Capable of supporting up to 100 Mbps (>10 of operation)
? Currently developing >1 Gbps fiber network for future Ka-Band support

Small Conversion Device (SCD)

? Provides an interface to the IONET which allows access to the NASCOM community
? Up to 3 Mbps of offsite capability

Clock and Data Recovery System

? Bit sync for the TSI FEP
? Supports I/Q downlink of up to 600 Mb per channel

TSI Front End Processor (FEP)

? Currently only Record/Playback Implemented
? Upgradeable to full FEP processing capability
? 600 Mbps capability (can support 75 Mbps and 150 Mbps station downlinks)
? 300 GB Redundant Array of Independent Disks (RAID) for recording

Loral Front End Processor (FEP)

? Second unit due to arrive in early 2003 for STS processing
? Operates up to 50 Mbps
? Current FEP has a full compliment of station cards
    ? 12 TAXI I/O cards (Fiber, ~50 Mbps, 8 payload channels/4 video channels)
    ? 3 TIO cards (RS422, <10 Mbps, 2 inputs/2 outputs)
    ? 1 HR TIO card (Fiber/ECL, 50 Mbps, 1 input/1 output)
    ? 2 DSP mezzanine cards (to support station audio and Reed-Solomon)

TSI Video Converter

? 4 video converter channels
? Each channel converts CCSDS VBSP packets to NTSC video

ESTL TAXI Test Set (HRFM Test Set)

? 12 TX/12 RX independent channels
? Each channel operates up to 100 Mbps
? Recover/Record 90 GB
? Bitstream mode
    ? Generate serial continuous data stream
        - Custom frame formats (constant, dynamic)
        - File playback of real data
        - Variable parsing schemes
        - Insert errors, illegal delimiter/TAXI codes, vary the clock frequency
    ? Recover/Record serial data
        - Real time checks
        - Post recovery analysis (bit for bit, byte for byte, frame for frame)
? CCSDS Packet mode
    ? Generate packet streams
        - Custom frame formats (constant/variable length)
        - File playback of real data
        - Insert errors, illegal TAXI codes, illegal lengths, vary the clock frequency
        - Variable parsing schemes
    ? Recover/Record serial data
        - Real time checks
        - Post recovery analysis (bit for bit, byte for byte, packet for packet)

ESTL Facility Manager

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